

THE BEES OF AUSTRALIA.

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There are, in all, 1,037 species of bees known from Australia (1), if we include fifty-eight which have been described and accepted for publication, but not actually published at the time these lines are written (August 10th, 1929), (2). There are, in addition 90 forms which are treated as sub-species or varieties. When they are better known, some of the supposed sub-species will doubtless take specific rank; but on the other hand, some of the recognised species will be united, the sexes having been given different names. Although the number of described species is so large, it is not probable that we know half of those actually existing. The fauna may contain as many as 4,000 species. This apparently extreme estimate appears justified when we consider that nearly all the collecting has been done in a limited number of localities, and that we know little concerning the bees of the interior of the country, or of the north-west coast. Mr. H. H. Batchelor has begun to send in specimens from Hughenden, in the interior of Queensland, west of the Dividing Range, more than 300 miles almost directly west of Mackay. The result is at once the discovery of large and conspicuous forms, hitherto unknown. There is doubtless a whole new fauna to be collected in that region. Rowland and Gilbert Turner collected intensively from 1883 to 1901 in the region about Mackay, on the Queensland coast. The bees were to have been described by Gilbert Turner, but he died of consumption in 1903, at the age of 37. A set of the bees was sent to Perez in France, but, although he attached manuscript names to many of them, he published nothing, and, so far as is known, made no descriptions. Perez having thus failed to accomplish anything, I was asked to undertake the work, using Turner's main collection, which had been given to the British Museum. After everything had been published, so far as the material permitted, the specimens sent to Perez came into the possession of Dr. H. Friese, who published a large number of descriptions without attempting to find out whether the species had been described by me. In a recent paper (American Museum Novitates, No. 343, 1929), I was obliged to reduce no less than 43 of the Friese names to the synonymy, and some others will doubtless have to follow. The Turner collections from the Mackay district included 97 new species of bees, many of them very striking forms, and some representing new genera. The Turners discovered a new series of excessively minute bees, some with peculiar venation, as the new genera *Turnerella* and *Heterapis*. These little bees often visit the flowers of *Eucalyptus* trees, high up in the air, but when the trees are cut down they are still attracted by the flowers and are within the reach of the collector. They are not confined to the Mackay region, but have been found in large numbers at Brisbane by Henry Hacker, from whose collections I have just published (Mem. Queensland Museum, ix., June, 1929) two new genera (*Zalygus* and *Microdontura*), four new species of *Turnerella*, two of *Euryglossina* and one of *Heterapis*. I had assumed, of course, that bees of this type were peculiar to Australia, but ten years ago I received a species of *Heterapis* (*H. sandacanensis* Ckll., 1919), collected in Borneo.

Although the Turners had found so many species in the Mackay district, Mr. Henry Hacker, collecting in the region about Brisbane, has ob-

(1) In 1904, 222 species were known; in January, 1913, 583 species.

(2) Since published, *vide Aust. Mus. Rec.*, xvii., 1929, 199-243.

tained 89 new species, and others in different parts of Queensland. Mr. F. X. Williams collected in the region about Halifax, and I recently examined his material, now in the possession of the Museum of Comparative Zoology, Harvard University. The species were in general identical with those obtained by the Turners, with only a few new species (*Nomia*, *Halictus*, *Meroglossa*). There is, however, a largely different fauna at Cairns and Kuranda, principally collected by R. Turner and F. P. Dodd. Some of the species from this district are very conspicuous and beautifully coloured.

Mr. Rowland E. Turner, in a letter dated January 6, 1929, gives the following interesting account of his collecting grounds: "The country in the Mackay district and in some other coastal districts in Queensland is of two utterly different types intermingled, grass with scattered *Eucalyptus* trees on the lower country, and tropical jungle on the hills and along the water courses. The bee fauna of the former class of country is Australian, most of the species frequenting *Eucalyptus* blossom, but the latter class of country has a vegetation mainly Malayan, and the bee-fauna also has many Malayan affinities (*Androgynella*, *Dianthidium* and others). *Eugenia* bushes usually grow on the edge of the jungle along the water courses, and were visited by many bees of an Australian type. Imported plants were not much visited except when related to native plants; thus *Cassia fistula* was visited by many species of *Hylaeus* and *Palaeorhiza*. The larger species of bees, belonging to wide-ranging genera such as *Xylocopa*, *Crocisa* and *Anthophora* were not particular, and frequented *Duranta* hedges. One species of *Meroglossa* visited roses, but this seems to be quite an exceptional case. *Leptospermum*, which is much visited by bees, especially *Paracolletes*, in the southern half of Australia, only grows among the rocks on the top of barren hills in North Queensland, where *Paracolletes* is also much more weakly represented, though some of the species are to be found on *Eucalyptus*. In south-west Australia, where there is no tropical jungle, the bee-fauna is almost entirely Australian, and mostly frequents *Eucalyptus* and *Leptospermum*, though *Pachyprosopis* and some other genera visit other plants. *Euryglossina* and some others of the smallest species are to be found crawling in the sticky cups of the *Eucalyptus* blossom. The pink blossomed West Australian *Eucalyptus ficifolia rosea* is particularly attractive to small bees. In South Africa, imported Australian plants are very little visited by indigenous bees.

In American Museum Novitates, No. 346 (1929) I have given a list of the known bees of the Northern Territory, principally obtained at Port Darwin, where I myself collected on March 12, 1928. The fauna is rather disappointing, with a preponderance of widely distributed genera, though there are species of *Euryglossa*, *Palaeorhiza* and *Turnerella*. A small *Paracolletes* (*P. tropicalis* Ckll.) occurs on Melville Island. There is, on the whole, little to suggest affinity with the fauna of New Guinea. I also visited Thursday Island, where most of the bees were taken at the flowers of the introduced *Antigonon leptopus*, which Mrs. H. M. Pendlebury had previously pointed out to me as being particularly attractive to bees at Kuala Lumpur, in the Federated Malay States. The Thursday Island series is on the whole similar to that from Port Darwin, with the bees and the wasps distinctively Australian so far as species go (3). No one could confuse the collection with one from New Guinea. Murray Island, in Torres Strait, has produced a very distinct species of *Palaeorhiza* (*P. hedleyi* Ckll., 1929), related to Queensland species.

(3) However, I collected *Odynerus mirabilis superbus* (Sauss.) det. Bequaert, which occurs both in Australia and New Guinea.

The Malay or intrusive element in the Australian fauna is characterised by the following genera:—

Ctenoplectra, with *C. australica* Ckll., from Claudie River, North Queensland, representing a family not otherwise known from Australia.

Trigona, with nine species, one occurring at least as far south as Sydney.

Allodape, with eight species, mostly northern, two of them only on Thursday Island.

Mesotrichia, with *M. bryorum* (Fabr.) frequently placed in *Xylocopa*.

Anthidiellum (species formerly placed in *Dianthidium*) with two species, one of them only on Thursday Island.

Coelioxys, four species, one (*C. froggatti* Ckll.) reported as far south as Victoria.

Nomada, one species from Queensland (*N. australensis* Perk.).

Sphecodes, one species from Queensland (*S. profugus* Ckll.).

It is noteworthy that all these genera occur also in Africa. Such genera as *Crocisa* and *Anthophora* might be added to the list, but they are now very widely disposed in Australia, with numerous species.

We naturally think of these insects as having entered Australia in comparatively recent times, but, as Mr. T. Iredale pointed out to me, there is evidence of a Malayan or Oriental snail fauna in North Queensland, which must be of considerable antiquity. As Rowland Turner points out, what we regard as the strictly Australian fauna inhabits a specialised environment, along with a peculiar flora; into this the so-called Malayan elements could rarely successfully penetrate, no matter how long they may have been in the country.

Coming now to the southern part of Australia, I cannot do better than quote a letter written by J. D. Hooker to Darwin as early as 1855:—

"I have just concluded a good and complete catalogue of the Australian Leguminosae. . . . Out of fully 800 species I do not think that there are a dozen common to South-East and South-West Australia; whole well-marked genera containing many sections and species are absolutely confined to S.W. Australia. There is nothing like this in any other part of the world; it is utterly astounding, and, though I thought myself well up in the Australian flora, I was not prepared for this to such an extent. Also taken as a whole, the flora of Tasmania does not present as many species hardly distinct from S.E. Australia as it ought. The Tasmanian species are either very distinct or quite the same, and what is most curious this applies as well to the alpine plants, though the climate of the Australian Alps must be a good deal different from that of the Tasmanian ones." (Life and letters of Sir J. D. Hooker, Vol. I., p. 448).

Much more recently, Emily H. Pelloe (Wild Flowers of Western Australia, 1921) has stated that W. Australia has about 4,000 species of wild flowers (not including over 2,000 of the tropical north-west), of which more than 3,000 are peculiar to that region.

These botanical facts are strongly reflected in the bee-fauna. It is in South-western Australia that we find an extraordinary abundance of species, belonging in large part to characteristically Australian genera. Rowland Turner collected for a time at Yallingup, near Cape Naturaliste, and got 46 new species. Dr. A. J. Nicholson, of the University of Sydney, obtained a small collection in the Geraldton district, and most were new, the species showing little in common with the Yallingup lot. The most remarkable was the large and handsome *Stenotritus nicholsoni* Ckll., forming a new sub-genus (*Ctenocolletes*), strongly suggestive of the South American *Caupolocana*. He also found a series of new species of *Euryglossidia*, which on closer study is seen not to belong to the Hylaeidae, but to be a Diphaglossine with two cubital cells, analogous to the South African

genus *Strandiella* of Friese. Still, again, George Masters secured some bees a number of years ago at King George's Sound, and these also represent a distinctive fauna, with several fine new species. Thus Western Australia not only possesses a very peculiar bee-fauna, but includes several faunulae, with special species of their own. The results obtained from a few collections in different parts of this great region certainly indicate a rich harvest remaining for anyone who will go at the proper season and collect in districts not yet explored by those interested in wild bees. The best results would be obtained through the co-operation of an entomologist and a botanist, the latter identifying the flowers visited by the bees.

Botanists have sometimes been sufficiently interested to collect bees. We are indebted to Von Mueller, the famous authority on the Australian flora, for the discovery of *Halictus luteoaeneus* Friese and *Nomia testaceipes* Friese. Schomburgk, who was Director of the Botanical Garden at Adelaide, discovered the species *Euryglossa chrysocerus* Ckll., *E. sinapipes* Ckll., *E. schomburgki* Ckll., *Hylaeus chrysaspis* Ckll., *H. dromedarius* Ckll., *Halictus clelandi* Ckll., *Parasphcodes schomburgki* Ckll., *P. sertus* Ckll., *Megachile adelaidae* Ckll., *M. semicandens* Ckll., *M. sequior* Ckll., and *M. trichognatha* Ckll. The types of all these are in the Berlin Museum.

Ludwig Preiss, who settled on Swan River in 1838, is remembered for his many contributions to the knowledge of plants, but also for his discovery of certain bees, as *Megachile preissi* Ckll. and *Anthophora preissi* Ckll. His specimens are at Berlin.

In 1916 (Proc. Acad. Nat. Sci. Philadelphia, p. 360) I listed 79 species of bees from Tasmania, in contrast with the meagre fauna of 18 known from New Zealand. Since that time, the Tasmanian list has been augmented, but new collections continue to emphasise the fact that Tasmania is faunally very close to Victoria, with the species at least in large part identical (4). Extending the thought suggested by Hooker, we may say that whenever Tasmania possesses strongly marked endemic species, they must be supposed to have survived there, and died out on the mainland. But the separation of Tasmania is so recent, that there is little evidence of divergence of type in the species isolated by that separation. The condition of affairs is in many respects similar to that of the British Islands in relation to the Continent of Europe.

Wherever bees are studied, it is found that some of the species are very widely distributed, while others are of much more limited range. This difference is likely to be correlated with flower-visiting and nest-building habits. The bees which we call polytropic, which gather nectar and pollen from many kinds of plants, are naturally likely to be of wide range; while the oligotropic bees, confined to one or a few species of plants, are commonly more restricted. These relationships have not been worked out in Australia, but it is a fact that certain species range over a vast territory. Some examples are the following:—

Paracolletes carinatus Sm., Tasmania to Kuranda, Queensland.

P. plumosus Sm., Swan River to Sydney.

P. vigilans Sm., Swan River to Tasmania.

Callomelitta littleri Ckll., Tasmania to National Park, Queensland.

Euprosopis elegans Sm., Adelaide to Brisbane.

Megachile doddiana Ckll., reported from W. Australia and Townsville, Queensland.

M. chrysopyga Sm., W. Australia to Tasmania and Brisbane.

(4) A very distinct species, *Hylaeus xanthosphaera* Ckll., was taken by J. A. Kershaw on King Island, and has not been found elsewhere.

M. erythropygæ Sm., Perth to Melbourne.

M. quinquelineata Ckll., W. Australia, and Melbourne to Cape York.

Euryglossina hypochroma Ckll., Perth and Brisbane.

There are indications that southern (e.g., Tasmanian) species may be found at higher altitudes northward, but at present we have very little material from the uplands and mountains, at least with distinct indication of the altitude. Careful collecting in various mountain localities is sure to give results of great interest. My wife went to the Jenolan Caves, N.S.W., at a most unpromising time of year (April 29th), yet of three species of *Parasphcodes* obtained, one was entirely new (*P. wilmattæ* Ckll.), and one was a sub-species of a Tasmanian species.

The first Australian bees to be described were collected by Banks and Solander on Captain Cook's first voyage, and were made known by Fabricius. These were *Mesotrichia bryorum*, *Lestis bombylans*, *Megachile mystacea*, *Hyleoides concinna* and *Anthophora cingulata*; the last not published until 1804. The *Hyleoides* was very naturally taken for a wasp, and described under *Vespa*. A letter written in 1773 by the English entomologist Drury refers thus to the work of Fabricius:—

"I think you remember Mr. Fabricius. He is now in London and very busy in making descriptions from Mr. Banks' and my collections, where he will have employment for some months, a pleasure he seems to enjoy with as much glee as a Lover of Wine does ye sight of his Cellar when well stored with full Casks and Bottles, enjoying by anticipation ye pleasure he is to receive in emptying them."

One other bee from the collection of Banks, and said to be from "Nova Cambria," was described by the Rev. Wm. Kirby in 1802 as *Melitta cyanura*, and is now known as *Hylæus cyanurus* (5). I found in the British Museum a species identified as that of Kirby (see Ann. Mag. Nat. Hist., February, 1910, p. 138), but it differed from the description in having a black abdomen. Kirby describes his insect as follows: "Caput. Frons utrinque ad oculos macula magna irregulari flavescente. Antennæ nigrae. Truncus. Collare utrinque flavum. Tubercula flava. Scutellum puncto rotundo flavicanti insignitum. Squamulae nigrae. Alae subhyalinae, nervis nigris. Pedes nigri. Abdomen nitidissimum, atro-violaceum, lucidum, levissime punctulatum."

(5) Mr. Robert B. Benson has found what appears to be the type of *Hylæus cyanurus* (Kirby) in the Banks collection at the British Museum. It is a female and has no label. He finds that it agrees with no species given in my tables in Ann. Mag. Nat. Hist., 1910, and is not the species called *cyanurus* in the general collection at the Museum. It is about 7 mm. long, black, with an obscure bronze and bluish metallic tinge on abdomen. The punctures of head, mesonotum and postnotum are very strong and coarse. On the clypeus the punctures tend to be drawn out into longitudinal furrows. The yellow markings include lateral face marks, very broad below, but rapidly narrowing at level of antennae, and ending very acutely on orbital margin far up on sides of front; tubercles yellow, pronotum, with "the hind dorsal margin with a thin yellow line broken in the middle"; very small yellow spots on scutellum (hemispherical in outline) and post-scutellum (obtusely sub-triangular). Abdomen with puncturation very fine, the large spaces between the punctures shining, though the surface is very finely rugulose. This description is partly derived from the sketches sent by Mr. Benson. I conclude that the species has not been obtained in modern times. This is not very surprising as, for instance, Banks and Solander collected insects on Palm Island, whence we have no bees.

In some respects this appears nearer to *H. rotundiceps* Sm., described from Melbourne. After a considerable interval, the next addition was from the voyage of the "Coquille," a species described by Guerin in 1830 as *Andrena* or *Mellitidia australis* (6). Taschenberg (1883) admits the genus *Mellitidia* into his system in his table separating it from *Nomia* by the ocelli being in a triangle; the second cubital cell rectangular, decidedly higher than long, receiving the first recurrent nervure about the middle. The second recurrent nervure joins the third cubital cell beyond the middle. The marginal cell is pointed on the costa. Mandibles broadened, on inner side briefly tridentate. Antennae with slender flagellum. Region of scutellum with a tubercle or point. This bee has not been recognised in recent times, and I have nothing which seems to fit this description. (I do not possess the original work, but only Taschenberg's version).

In 1835 Boisduval described *Crocisa lamprosoma*, of which he said: "Cette belle espece est indiqe comme de Vanikoro, mais je le crois plutot d'Amboine ou de Celebes." Vanikoro is far out in the Pacific, 167°E., 11°, 40min. S. The insect is a well known member of the fauna of Queensland and New South Wales. The *C. caeruleopunctata* of Blanchard, 1840, appears to be the same.

The early voyagers were not always careful about localities; in 1841 Lepeletier described a *Crocisa novaehollandiae*, said to be from New Holland, but it actually inhabits Amboina.

In 1841 or 1842, Erichson described *Prosopis alcyonea*, *Hylaeus familiaris*, *Andrena infima* and *A. chalybeata*, all from Tasmania. The *Prosopis* is easily identified as the *P. vidua* Smith, 1853, now called *Hylaeus alcyoneus*. *Andrena chalybeata* is now known as *Paracolletes chalybeatus* (cf. Mem. Q'ld. Mus., ix., 1929, p. 311). *Andrena infima* is perhaps, but not certainly, an earlier name for the common *Halictus lanarius* Smith (cf. Trans. Amer. Ent. Soc., xxxvi., 1910, p. 236). It is a male, with apex of clypeus yellow; the face densely white-haired. *Hylaeus familiaris* is a much smaller (female) *Halictus*, not clearly recognisable from the description. It is said to have the margins of the tergites piceous, without bands, indicating such a species as *H. mesembryanthemi* Ckll., or possibly *H. helichrysi* Ckll., or *H. pulvitectus* Ckll. It is safe to exclude *H. helichrysi*, a Queensland species; but *H. pulvitectus* is Tasmanian, and *H. mesembryanthemi* is common in Victoria, and may well occur in Tasmania. It is too large for *H. mesembryanthemi*, and is excluded by the black antennae, front with a mixture of black hairs, and fuscous nervures and stigma. There is more resemblance to *H. pulvitectus*, except for the "fronte pilis intermixtis nigris," but it may well be a species not since collected. The length is said to be 2-2/3 lines.

At Oxford, in the Hope Museum, I found specimens of *Halictus* collected by Darwin on the voyage of the "Beagle," in Australia and Tasmania. They were ordinary looking, and without literature or specimens for comparison. I was not able to identify them. I regret now that I did not make descriptions, from which I could doubtless have placed them on my return home. They were, of course, new species when collected (7).

(6) I now learn from Dr. J. Bequaert that *Mellitidia australis* Guerin was actually collected at Port Praslin, New Ireland (Bismarck Archipelago). It is therefore not a member of the Australian fauna, in spite of having been treated as Australian all these years.

(7) Mr. Robert B. Benson informs me that bees labelled 444 at the British Museum (e.g., the type of *Paracolletes plumosellus* Ckll.) were collected by Mr. B. Bynoe, surgeon on H.M.S. Beagle. Bees labelled 56.94 (e.g.,

So far, the knowledge of Australian bees was extremely fragmentary, but F. Smith, of the British Museum, from 1853 to 1879, published 186 species, including many of those most commonly found. Some of the names proved to be preoccupied, and substitutes were provided by Dalle Torre in his Catalogue (1896). It is much to be regretted that Smith did not trouble himself to cite the collectors, and frequently (perhaps for lack of better knowledge) gave only "New Holland" or "Australia" as the locality. The types in the British Museum show that he copied what was on the labels, but probably in some cases more information might have been obtained. In the paper of 1868 seven species are cited from the collection of Sir John Lubbock, and it is known that the ten species from Champion Bay, Western Australia, were all obtained by H. Du Boulay. A remarkable bee, forming a new genus, had previously (1864) been named *Thaumatocoma duboulayi* by Smith.

Smith did not describe all the Australian material available to him. I have had to describe many species from British Museum specimens, dating back to Smith's time. I think the oldest date (as shown by the accession numbers) is 1844 (cf. *Paracolletes plumosellus*). Since the time of Smith species have been described by Alfken of Bremen (3), Cockerell (759), Friese (43, not counting those definitely known to be synonyms), Froggatt (*Megachile blackburnii*), Gribodo (*Anthophora scymna*), Meade-Waldo of the British Museum (7), Meyer of Darmstadt (5 *Parasphcodes*), Mocsary (*Trigona cincta*), Perkins (13), Radoszkowsky (3), Rayment (3), and Strand (*Euryglossa endeavouricola*). Mocsary's *Trigona* was actually described from New Guinea, and the Australian representative is a distinct sub-species, *T. cincta percincta* Ckll. The name of Linnaeus comes into the list on account of his *Anthophora zonata*, and the introduced honey-bee.

Several collectors of the modern period have already been mentioned, but it is important to mention the very numerous discoveries of W. W. Froggatt and C. French in New South Wales and Victoria. Thus, for example, no less than nine species of *Exoneura* were first found by Froggatt. Smaller contributions, but some of them of considerable importance, have been made by E. Allen, G. F. Berthoud (W.A.), F. L. Billingham (Bacchus Marsh), Horace Brown (W.A.), T. G. Campbell, J. S. Clark (Swan River), J. Burton Cleland (W.A.), C. E. Cole (Tasmania), Coulon (Port Philip, specimens in Berlin Museum), W. H. Davidson (Queensland), H. W. Davey (Bright, Victoria), A. P. Dodd, Hy. Edwards (the American actor and lepidopterist, who visited Australia), S. W. Fulton (Victoria), Miss A. M. Fulton (Croydon, Victoria), C. Gibbons (N.S.W.), G. F. Gill (Victoria), G. H. Hardy, R. Helms, G. F. Hill, H. J. Hillier (Hermannsburg), Harold Hockings (species of *Trigona*, with biological observations), R. Illidge (Cunderdin, W.A.), R. Kelley (Healesville, Victoria, a wonderful collection from flowers of *Eucalyptus calophylla rosea*, sent to Professor Poulton at Oxford), Wm. Kershaw, Arthur M. Lea, F. M. Littler (Tasmania), A. Musgrave, W. R. Salter (N.S.W.), F. P. Spry, W. Stalker (Alexandria), A. J. Turner (Queensland), H. W. J. Turner (Perth), J. J. Walker (on the "Penguin" Expedition, including the remarkable genus *Phenacolletes* from Turtle Bay), G. A. Waterhouse, F. E. Wilson (Victoria), C. M. Worsfold (W.A.), and others. This long list shows that there has been a good deal of interest in collect-

the type of *Paracolletes providellus* Ckll.) were collected by Mr. Stutchburg between Sydney and Moreton Bay. Bees labelled 69.50 (e.g., the type of *Paracolletes rudis* Ckll.) were purchased from Mr. Du Bouley, collected in W. Australia, at Nicol Bay, Swan River and Champion Bay.

ing Australian bees, and suggests that when it is made possible for amateurs to identify their species, the bees may become favorites with them.

Friese obtained many species secured by Frank on a journey to Australia, and described several as new. The dates seem to show that Frank did not remain long in any one place, and there is reason to believe that part of the material was given to him by Australian entomologists. Two specimens of *Paracolletes* bear Froggatt's labels. Specimens in the Berlin Museum are ascribed to Rolla, but I understand that he merely sold the specimens, and presumably did not collect them.

The greatest number of types of Australian bees will be found in the British Museum, including those of Smith and Meade-Waldo, and very many described by myself. The American Museum of Natural History in New York has 28 types of species and varieties described by myself, and a long series of the Australian types of Friese. It has been the custom of Friese to label all his co-types "type," without designating holotypes; and his collection, now in Berlin, contains another set of "types" of these species. The Museum of Comparative Zoology (Harvard University) has six types, and the type of *Halictus melanurus* Ckll. is in the U.S. National Museum. The Berlin Museum has many types of my species, as well as those of Friese and Meyer.

In Australia, the largest and richest collection is doubtless that in the Queensland Museum, beautifully arranged by Mr. Hacker, to whom we are indebted for the invaluable Catalogue of Australian Bees, published in the Memoirs of the Queensland Museum, 1921. This collection is now rich in types and determined species. Next comes the series in the Australian Museum at Sydney, also kept in excellent order, and now enriched by numerous types of species described by me in Rec. Aus. Mus., xvii., 5, p. 199. The National Museum of Victoria, at Melbourne, has a smaller series, but includes some very good things. There is a fair number of types and co-types. At the present time, the Australian student has access to a very much larger number of determined bees than was the case a few years ago. I still have in my possession a great many types of Australian species, which have been very necessary for my studies. But I hope in time to transfer most of these to Australia, especially when I can secure in return other specimens of the same species, which I can verify before parting with the types. I have not been willing, in America or Australia, to work up collections and return the types to private collectors, because such a policy is likely, in the long run, to lead to serious losses. I should make an exception in the case of a large collection of some well known student of bees, which was sure to go intact to a reputable museum. It cannot be too strongly emphasised that a type is, from its nature, to be regarded in a manner as public property. It is proper to add, in this connection, that access to types does not necessarily ensure accuracy of determinations. I have known cases where errors were made in such comparisons, when the slightest attention to the descriptions would have revealed the mistakes. Indeed, I myself often read my own descriptions before making comparisons, to call to mind the particular specific characters. The best discipline for the student of bees, whether young or experienced, is to make tables of the species in hand. This it is often difficult to get students to do. They would rather avoid the trouble, and rely on general impressions. It is my custom to construct a table or key for any considerable series of species to be determined, leaving it for subsequent investigation to determine what they are and if any are new.

The habits of Australian bees have been little studied, but will abun-

dantly repay investigation. Some work has been done by Mr. H. Hacker at Brisbane, but the most interesting studies have been made by Mr Tarlton Rayment at Sandringham, Victoria. With the utmost enthusiasm he has watched and recorded the nesting habits of the species of his neighbourhood, discovering many hitherto unrecorded facts. In 1928, I had the pleasure of visiting his favourite localities in his company, though unfortunately not at the best season of the year.

If I may express a personal wish in relation to Australian bees, it is that I may live to see some young student, man or woman, take up the study in Australia and have sufficient perseverance and skill to carry it far beyond the present stage. Indeed, why should there not be half a dozen such students? In that case it would no longer be necessary to send collections across the ocean for determination, and Australia would have the satisfaction of mastering her own problems in this field, as she has done in so many others.

APOIDEA (8).

The bees are to be regarded as constituting a superfamily Apoidea, closely related to and presumably derived from the fossorial wasps. In some cases (e.g., *Phenacolletes*) it is at first sight hard to determine whether an insect is a bee or a wasp; but, as Edward Saunders long ago pointed out, all bees, even parasitic species, have some plumose hairs, while the fossorial wasps have them all simple. This fact may be taken as evidence, if such were needed, that the parasitic bees are derived from nest-building forms; and when we come to study parasitic bees in detail, it is evident that they themselves are variously related to and derived from different families of working bees. Any attempt to reconstruct the phylogeny or lines of descent of the bees must necessarily result in a fan-like diagram. Although we can assert with considerable confidence that certain genera are genetically related (thus the parasitic *Psithyrus* derived from *Bombus*), the origin of the families evidently goes a long way back, to a time of which we have no record. It is easy to prove that certain types cannot have been derived from certain other ones, but quite a different matter to determine their actual origin.

It has been customary to regard the bumble-bees (*Bombus*) as very advanced, on account of their long tongues, reduced palpi and social habits. Nevertheless, they show primitive characters in the wings. The sawflies, admittedly standing at the base of the hymenopterous series, frequently show two marginal or radial cells, a dividing vein descending, usually obliquely, from the apical portion of the stigma. In such a wasp as *Zaspilothynnus*, the base of the radius as understood in sawflies is preserved, and the marginal nervure is strongly looped up to the stigma, so that the marginal cross-vein is excessively short. This wasp, however, surely has two marginal cells, in the same sense that the sawflies have two. Now even in *Bombus*, the rudiment of the cross-vein in the first cubital cell is plainly visible, and it may be said that it also has two marginals. (Cf. Ann. Mag. Nat. Hist. Oct., 1927, pp. 433-434).

Hair on the eyes is found in the genus *Glyptapis*, from Prussian amber, and may be an ancient character. In the modern fauna it is seen in the honey-bee (*Apis*), in the totally different (parasitic) genus *Coelioxys*, in

(8) I assume that the reader is in possession of some good general work such as Tillyard's "Insects of Australia and New Zealand," and as far as possible avoid the repetition of what may be readily found therein. I also assume the possession of Hacker's catalogue.

the again wholly diverse Australian *Trichocolletes*, and to a slight extent in some other genera. It does not seem at all probable that hairiness of the eyes can be taken in any sense to indicate relationship, but it appears to represent a latent tendency cropping out here and there.

With regard to the tongue, it is entirely reasonable to regard the short tongue as primitive, the long one as more advanced. The length of the tongue increases as an adaptation to the flowers from which nectar is obtained. This culminates in the South American *Euglossa* (*Glossura*) *piliventris* Guerin, in which the tongue is much longer than the body, and when folded back sticks out behind like a tail. In former times, it was very convenient to divide the bees into two great sections, one with the tongue short and blunt, usually more or less emarginate or notched, and the other with the tongue, whether long or short, acutely pointed. The distinction appeared to be fundamental and absolute. However, Perkins (Proc. Hawaiian Ent. Soc., 1908), describing the new Australian genus *Palaeorhiza* (type *Prosopis perviridis* Ckll.), proposed a family Palaeorhizidae, on the following grounds:—

"*Palaeorhiza* is evidently represented by many species in Australia. Several have been described as belonging to the genus *Prosopis*, in spite of the fact that the most superficial examination shows that these insects have an acute lanceolate tongue. Hitherto no connecting link between the blunt-tongued and acute-tongued bees has been recorded, but in *Palaeorhiza* we have a form, which, except for the structure of the tongue, would be assigned to the section of Obtusilingues. It will therefore be obvious that this section and the Acutilingues can no longer be maintained as of great importance, since *Palaeorhiza* must always be associated with *Prosopis*, as the male genital characters, and all other ones, save the lingual, clearly show. In this connection, however, it is only proper to add that the Australian genus *Meroglossa*, associated by Smith with the blunt-tongued bees, without remark, has an acute tongue, being so figured and described by that author."

This extraordinary condition of affairs naturally led me to examine the material in my possession, with the result of discovering a still more extraordinary circumstance, that the males of those two genera do in fact have acute tongues, but the females have them obtuse, as in the related genera! Thus the two sexes, according to the old classification, would fall in quite different divisions of the Apoidea. (Cf. Nature, Vol. 83, 1910, p. 311).

The maxillary palpi are especially instructive from the standpoint of evolution, since there is no doubt whatever that the primitive number of joints is six, and that these undergo reduction in the different genera, being wholly lost in the South American genus *Oxaea*. This reduction has evidently taken place independently in different groups; thus *Oxaea* is not related to the various genera in which the joints are two, three or four, but to *Protoxaea*, which has six-jointed maxillary palpi. A very interesting case is that of the Australian genus of Anthophoridae called *Asaropoda*, in which the maxillary palpi retain the full number of six joints; but the labial palpi, four-jointed in nearly all bees, are reduced to two joints, with a brush of stiff hairs at the end. This has been confused with *Saropoda*, which is a European genus, with four-jointed maxillary palpi. It will be observed that, speaking generally, the reduction in the number of palpal joints is characteristic, not of the endemic Australian genera, but of the genera which evidently evolved elsewhere, and entered Australia with their generic characters fully established.

The maxillary combs are evidently highly significant for taxonomy and the understanding of phylogeny. The combs consist of rows of stiff specialised bristles, placed on the maxilla, and only clearly seen when the mouth-parts are mounted on a slide, and examined by transmitted light under the compound microscope. The inner comb is placed mesad of the palpus, on the basal part of the galea. The outer comb is placed basad of the palpus, on a more or less concave margin of the stipes, or more properly perhaps the united palpifers. The presence of the inner comb distinguishes those bees which are considered less advanced, and the presence of the outer comb those which are very highly modified. *Hylaeus*, *Merglossa*, *Palaeorhiza* and others have the inner comb very well developed; the lacinia in those genera is reduced to a small finger-like structure, beset with bristles. *Nomia* has a well developed inner comb, and narrow lacinia. *Sphecodes* has no inner comb, but it has a primitive feature in the palpus, the apical part being distinctly separated, a condition more strongly emphasised in the wasp *Vespa*. *Halictus* has no inner comb, and the terminal portion of the galea is separated by a line or suture as in *Sphecodes*. Thus *Halictus* and *Sphecodes* stand apart from *Nomia*, which has no apical division of the galea. Owing to these facts, I am now inclined, contrary to my former opinion, to accept the family Halictidae as distinct from Andrenidae.

The Anthophoridae, such as *Anthophora*, have a well-developed outer comb. *Megachile* has no inner or outer comb. The margin below the galea is strongly convex, but presents a certain number of bristles, which in some species are thickened and spiniform. These seem to represent the vestiges of an outer comb. The Megachilidae (except *Anthidium* and close relatives) are outer comb losers, but some other genera of more primitive type presumably had no outer comb ancestry. (Cf. Proc. Ent. Soc. Washington, Vol. 26, April, 1924).

Returning to a consideration of the wings, we can clearly detect an evolutionary series in the suppression of the cells and nervures. The more primitive genera have three cubital (or sub-marginal) cells and three discoidals. Many genera have the cubital cells reduced to two, and when this is the case, it may be the first or second intercubitus which has disappeared, or perhaps the two may have coalesced to form a single nervure. In the North American parasitic genus *Phileremulus*, and in some of the minute Australian Hylaeidae, there is only one cubital cell, while in the Meliponidae (represented in Australia by *Trigona*) the dividing nervures have entirely disappeared, or are represented at best by faint vestiges. Although the loss of a cubital cell indicates departure from the primitive type, this is the condition in the whole group of Hylaeidae, otherwise considered primitive, and in certain members of the Colletoid series.

It is proper to remark, that from the standpoint of strict morphology, we are in error in our nomenclature of the cubital cells. Thus it is obvious that a genus with two cells does not possess just the first and second of other bees, but the first, and it may be the second and third united. This is well understood, and need not give rise to any misunderstanding.

The Australian bees can be divided into a number of families called Hylaeidae (or Prosopididae), Colletidae (of the sub-family Diphaglosinae), Halictidae, Andrenidae (of the sub-family Nominiinae, or family Nomiididae of Robertson), Melectidae (*Crocisa*), Anthophoridae (*Anthophora* and *Asaropoda*), Megachilidae (with sub-families Megachilinae, Anthidiinae, and Coelioxynae), Xyllocopidae, Ceratinidae, Meliponidae, and the introduced honey bee, Apidae.

The following key will facilitate the separation of these groups:—

- Cubital cells, obsolete or in part faintly indicated; social bees. Meliponidae (*Trigona*).
 Cubital cells, whether one, two or three, clear and distinct. 1.
 1. Cubital cells two or fewer. 2.
 Cubital cells three. 9.
 2. Short tongued bees, the tongue obtuse, except in males of
 some Hylaeidae, but never long. 3.
 Long tongued bees. 6.
 3. Both cubital cells long, subequal, well developed. 4.
 Second cubital cell conspicuously shorter than first, or
 lacking. Hylaeidae.
 4. Second cubital cell broadly and abruptly truncate apically, the cell
 as broad above as below; rather large bees resembling wasps. . . .
 Hylaeidae subf. Hylaeoidinae (*Hylaeoides*).
 Second cubital cell narrowed about or nearly half above. 5.
 5. Abdomen with pale tegumentary bands, incised on each side anteriorly;
 antennae and hind legs highly modified; marginal cell pointed, the
 apex away from costa; basal nervure going basad of the very
 oblique nervulus. Hylaeidae subf. Neopasiphaeinae (*Neopasiphae*).
 Abdomen without pale tegumentary bands, but frequently tinged with
 purple; antennae and legs not deformed; marginal cell narrow at
 end near costa; basal nervure falling short of nervulus.
 Colletidae (*Euryglossina*).
 6. Only one recurrent nervure, and therefore only two discoidal cells. . .
 Ceratinidae (*Exoneura*).
 Two recurrent nervures, and three discoidal cells. 7.
 7. Small or smallish bees, with not much hair on body; females with no
 scopa on abdomen, but one on hind tibiae and basitarsi; face
 usually with a characteristic pale mark; abdomen never blue. . .
 Ceratinidae [(*Allodape*)].
 Rather small thick-set bees, the abdomen shining purple-blue. . . .
 Ctenoplectridae (*Ctenoplectra*).
 Small or large bees, evidently hairy; females (except in *Androgynella*)
 with a ventral scopa (pollen-collecting brush) on
 abdomen. 8.
 8. No pale tegumentary markings; no pulvillus or pad between
 claws. Megachilidae.
 With pale or yellow tegumentary marking; feet with pulvilli.
 Megachilidae subf. Anthidiinae (*Anthidiellum*).
 9. Bees with short obtuse or emarginate tongues; body hairy. Colletidae.
 Bees with pointed tongues, short or long. 10.
 10. Marginal cell very long, parallel sided, approaching tip of wing;
 second cubital very broad below and narrow above; social bees
 with hairy eyes. Apidae (*Apis*).
 Marginal cell not thus elongated; solitary or colonial bees, not forming
 a community nest. 11.
 11. Sixth abdominal segment without a pygidial area or plate; tongue long
 and filiform; bees making nests in wood or in stems of
 plants. 12.
 Sixth abdominal segment with a pygidial area or plate. 13.
 12. Small bees, less than 5 mm. long; black, marked with white; second
 intercubitus strongly curved, nearly meeting the first above;
 maxillary palpi five jointed. Ceratinidae (*Neoceratina*).
 Large robust bees, like bumble-bees, black or metallic. Xylocopidae.

13. Parasitic bees, without scopa for collecting pollen; ornamented with bright blue or white markings due to appressed scale-like hairs; scutellum modified, emarginate. Melectidae (*Crocisa*).
Nest-making bees, with scopa on the legs of females for collecting pollen; body not ornamented as in *Crocisa*. 14.
14. Tongue very long, and first two joints of labial palpi strongly modified, elongated and flattened; robust swift-flying bees. . . Anthophoridae.
Tongue dagger like or more elongated, but labial palpi not modified as just described; bees mostly of medium size or small. 15.
15. Second cubital cell short and small, the others large; marginal cell blunt at apex; hind legs of males often greatly modified.
. Andrenidae subf. Nomiinae.
Cubital cells more ordinary, and marginal cell more pointed; basal nervure strongly bent or arched; males usually with a yellowish band or mark on apex of clypeus. Halictidae.

Aside from such characters as are cited above, each group has its general aspect or facies, by which it may usually be known at a glance, once it has become familiar. Additional characters will readily be found; thus the base of the metathorax in *Nomia* is unlike that of *Halictus*, and the Halictine females have a sort of groove or rima, fringed with hairs, at the apex of the abdomen. The commonest Anthophorids have the abdomen elegantly banded with blue or green, but some Nomiines are also thus banded. The marginal cell in Anthophora is short, evidently shorter than the first discoidal, and the basal nervure is not arched. *Anthophora* and *Asaropoda* have the third cubital cell large and square, hardly contracted above.

Family APIDAE.

The honey-bee, *Apis mellifera* L., is sufficiently well known. One of its specialised characters is that of lacking spurs on the hind tibiae (9).

Many years ago I saw a bumble-bee (Bombidae; *Bombus hortorum* var. *fidens* Harris) said to have come from Queensland. Species of *Bombus* are well established in New Zealand. In the Western Hemisphere there is a native *Bombus* (*B. dahibohmti* Guerin) existing as far south as Tierra del Fuego.

Family MELIPONIDAE.

All the Australian species are small and belong to the genus *Trigona* Jurine. These bees are peculiar for having no sting.

Trigona carbonaria Smith. This is the very common little black bee, looking like an animated particle of soot, about 4 mm. long. The pale hair of the thorax above has sparse black bristles intermixed. The flagellum of the antennae is dark beneath, with at most a little red at base and more at apex. The native name, according to Mr. Hockings, is Karbi. Although it is a general rule that native bees are attracted by introduced flowers, there are exceptions, and one of them is *T. carbonaria*, which Mrs. Maybanke Anderson found to be attracted in great numbers to sunflowers at Pittwater, N.S.W. (Cf. Entomologist, July, 1914, p. 192). At Rangoon, Burma, I found a similar small *Trigona* (*T. iridipennis* Smith) attracted in numbers to sunflowers.

(9) Mr. T. Rayment (Australasian Beekeeper, xxvii., October 15, 1925, p. 68) reported the existence of a smaller native *Apis* (*A. aenigmaticus* Rayment) from Victoria and South Australia. But as nothing seems to be known of it but the comb, it cannot be regarded as entitled to recognition until the actual bees are produced.

Trigona carbonaria angophorae Ckll. Worker about 4.5 mm. long, intense black, without light markings, but the flagellum ferruginous beneath. Wings blackish translucent, with dark stigma and nervures; legs with black hair. This was found by Froggatt visiting flowers of *Angophora* at Sydney, and was described as a distinct species, but it seems to represent a race or variety of *T. carbonaria*.

T. carbonaria hockingsi Ckll. Larger than typical *T. carbonaria*, with much coarse black hair on scutellum, and the flagellum clear red beneath. It was found by H. Hockings on the Cape York Peninsula, and also occurs (with the flagellum more dusky) at Port Darwin. The nesting habits are different, and are described in Mem. Queensland Museum, ix., 1929, p. 301.

T. cassiae Ckll. Easily known from *T. carbonaria* by the scutellum, and often the axillae, marked with cream colour. The tubercles also are light-spotted. In the male the flagellum is entirely pale fulvous beneath. It is common in Queensland, nesting in hollow trees, and commonly visiting *Cassia* flowers, but also *Eucalyptus*. The native name, according to Hockings, is Kootchar. He has given a good account of its nesting habits (Mem. Queensland Museum, ix., 1929, p. 299, continued on p. 301).

T. cincta percincta Ckll. A very small species with light face-markings, pale scutellum, and a pale band along each side of mesothorax. The species was described from New Guinea, but an Australian race, appreciably larger (up to 5 mm. instead of 3.5) occurs at Hermannsburg, Finke River.

T. australis Friese, found by Baron von Muller in Central Australia, and also reported from Queensland, has the scutellum partly pale as in *T. cassiae*, but is said to have yellow mandibles and red-brown clypeus. The axillae are entirely yellowish white. Length, 4 mm. I infer from the description that true *T. australis* is a species I have not seen, but probably the variety from Mackay, cited by Friese, to *T. cassiae*.

T. essingtoni Ckll., from Port Essington, is 4 mm. long, with pale yellow markings, as follows: Mandibles (except ferruginous tips), labrum, clypeus (except narrow, black, anterior and posterior margins, and two large red-brown spots on disc), wedge-shaped lateral face-marks, extending to level of antennae, tubercles, narrow stripe on each side of mesothorax, extending to level of antennae, tubercles, narrow stripe on each side of mesothorax, extending to axillae, all of scutellum, and apex of abdomen, the last being thinly pubescent with white hair. Wings hyaline, nervures and stigma flavous.

T. mellipes Friese, with no better locality than South Australia, is honey-yellow, with hair of the same colour; antennae blackish-brown above; legs all honey-yellow; wings perfectly clear, iridescent. Length less than 4 mm.

T. wybenica Ckll., found by Hockings on Thursday Island, is very small, head and thorax shining black, with the scutellum, metathorax and sides of thorax posteriorly varying from dull honey colour to black (perhaps a question of maturity). Mandibles light yellowish ferruginous, darker at apex; labrum light yellow; scape entirely clear orange ferruginous; flagellum black or very dark above, reddened beneath, especially apically; abdomen, honey colour or pale yellowish.

T. laeviceps Smith. Resembles *T. carbonaria*, but distinguished by the red antennae; the abdomen is dark sepia brown, becoming black apically. It occurs in Queensland and the Northern Territory (Adelaide River), and was first reported in error as *T. canifrons* Sm. (Cf. Mem. Queensland Mus., vii., 1922, p. 279). Even now, there is some uncertainty, as recent studies indicate that the *T. laeviceps* of authors includes more than one species.

Family XYLOCOPIDAE.

Large robust bees not metallic; second cubital cell produced and incomplete basally. *Mesotrichia* Westwood.
Bright green or blue bees; second cubital cell approximately parallel-sided, complete, not strongly produced at base (the venation therefore less modified than in *Mesotrichia*). *Lestis* Lepeletier.

Mesotrichia Westwood.

Mesotrichia bryorum Fabricius. The female is a large black bee, the thorax covered with dense very bright yellow hair. The male has the abdomen also yellow haired. It is a common insect in Queensland, but has been reported as far south as New South Wales. The bees of this genus are known to possess a peculiar pouch in the base of the abdomen, which harbours mites of the genus *Paragreenia*. Miss N. Le Veque has discovered the interesting fact that the Australian species lacks this pouch, and therefore harbours no mites.

Lestis Lepeletier.

Lestis bombylans Fabricius. Male with thorax and abdomen yellowish green, the thorax in front with fulvous hair, with three longitudinal suffused dusky bands. Female bright blue-green. Queensland.

L. aerata Smith. Male with thorax and abdomen bluish-green, with blue shades on thorax; front much narrower than in *L. bombylans*; thorax in front with three black bands and fulvous between them; light area on face pellucid or opaque white. Female bluer than in *L. bombylans*. The var. *violascens* Kkil. (male) has much violet colour on abdomen. The var. *gibbonsi* Kkil. (National Park, N.S.W.) described from a male, has the black band on middle of thorax in front broader; thorax above yellowish green, the shining disc of mesothorax golden green; abdomen shining yellowish green with strong pink and lilac suffusion.

This species appears to be more widely distributed than *L. bombylans*, extending from North Queensland to Victoria.

Family CERATINIDAE.

Anterior wings with three cubital cells. *Neoceratina* Perkins.
Anterior wings with two cubital cells. 1.
1. Anterior wings with two recurrent nervures.
. *Allodape* Lepeletier and Serville.
Anterior wings with one recurrent nervure. *Exoneura* Smith.

Allodape was based on a South African species, but the genus is widely distributed in Africa and Asia, extending to Australia. *Exoneura* is an Australian derivative from *Allodape*; it is an example of an Australian genus which is less primitive than its relatives in other parts of the world. The Syrian *E. libanensis* Friese, which I have from Brumana (*Morice*), appears to represent an independent development, and is now placed in *Exoneuridia*. *Neoceratina* was based on peculiarities of the palpi and venation, but Perkins overlooked the fact that the type of *Ceratina* (*C. cucurbitina* Rossi) has five-jointed maxillary palpi (cf. Ann. Mag. Nat. Hist., Dec., 1899, p. 405). *Neoceratina* is therefore very close to *Ceratina*, but should be readily recognisable by "the recurrent nervures received a short and about equal distance within the second and third cubital cells respectively." The only species is *N. australensis* Perkins, 4.5 mm. long, taken by Perkins at Bundaberg, Queensland, in 1904. It is black, with a slight aneous tinge; a wide stripe down middle of clypeus, the tubercles, a spot at base of middle tibiae above and line on front and hind ones are white.

Allodape Lepeletier and Serville.

Allodape bribiensis Ckll. Female about 4 mm. long; black, the abdomen dullish, not shining as in *A. unicolor*; clypeus with a broad white vertical bar, narrowest at top, and gradually widening downward; scape black; flagellum ferruginous beneath, except at base; tegulae testaceous; tubercles white; legs with white marking. Found by Hacker on Bribie Island, Queensland.

A. clarissima Ckll. Male; 6.8 mm. long; like *A. simillima*, but scape with a white stripe in front; clypeus broad, constricted in middle, ivory-white; small lateral face marks; labrum white in middle; tubercles white; tarsi pale red. Thursday Island.

A. diminuta Ckll. Both sexes about 5 mm. long; resembling *A. simillima*, but much smaller, and male with scape white in front. Face mark in female broad and pyriform, which readily distinguishes it from *A. unicolor*. Discovered by Froggatt at Yarrawin, N.S.W., but now known to extend north to Thursday Island and Port Darwin.

A. grisea Alfken. Male, 4.25 mm. long; black, dull, with thin grey hair; legs marked with yellowish white, and hind margins of abdominal segments above and below yellowish white; wings perfectly clear, iridescent. No mention is made of any pale markings on head. Denham, S.W. Australia, taken on the Hamburg Expedition of 1905. Unknown to me.

A. picta Smith. I examined Smith's (male) type in the British Museum. It is recognised by the yellow sides of face, and the abdomen with suffused brown bands. The clypeus is yellow; mandibles and labrum testaceous yellow; antennae pale fulvous beneath; tegulae testaceous; wings clear, nervures testaceous; abdominal tergites 2 to 4 with lateral yellow spots. The length is given as $2\frac{1}{2}$ lines. The abdominal markings appear to ally it with *A. grisea*. Unfortunately the locality is given as "Australia."

A. plebeia Ckll. Male 6 mm. long; like *A. simillima*; but no lateral face marks; facial mark yellowish; very broad above, gradually narrowing to the truncate lower end; labrum all black; antennae entirely black; tubercles cream-colour; stigma very dark. Female about 6 mm.; marked like the male, but more robust. Thursday Island.

A. simillima Smith. The largest Australian species; females up to nearly 9 mm. Black, the female with a large pear-shaped yellowish-white area on clypeus, and the tubercles white. The type locality is given as "Macintyre River (Ker)." The species goes north to Thursday Island and Melville Island, and occurs at Brisbane and in W. Australia. It is possible that the species as now understood is composite. The male, as I have it from Mackay, has the clypeus all white, and the sides of the face with narrow white bands. This is Turner's 716.

A. unicolor Smith. A small species. Smith described the female as "length $2\frac{1}{2}$ lines; black and shining, the clypeus having an elongate cream-coloured spot, transverse at the base and pointed at the apex; . . . wings hyaline, their extreme base yellowish, the nervures fuscous." The locality is given as "New Holland," but the species is known to be northern. The male, from Port Darwin and Thursday Island, is less than 4.5 mm. long, and has no lateral face marks. The scape is entirely black. The female may be known from *A. bribiensis* by the lack of white marking on the legs.

The Australian *Allodape* appear to fall in two series; the species of Queensland and the Northern Territory (one extending into New South Wales), which are quite typical of the genus; and the aberrant *A. picta* and *A. grisea*, little-known, and probably confined to S.W. Australia. I possess no material of the second group.

Exoneura Smith.

Numerous species have been added since the publication of Hacker's Catalogue. For most of these, see Memoirs, Queensland Museum, vii., December, 1922, where there is a table. In this table, *E. pictifrons* Alfken would fall next to *E. perpensa*, and *E. hamulata* Ckll. next to *E. baculifera*. For a table of the earlier known species, see Ann. Mag. Nat. Hist., November, 1905. The genus is very rich in species, and should be intensively studied by an Australian entomologist. It is remarkable that S.W. Australia seems to be very poor in *Exoneura*, only *E. bicolor*, *E. pictifrons* and *E. angophorae occidentalis* being recorded. There are four species in Tasmania.

Exoneura abstrusa Ckll. Male, about 6.5 mm. long; clypeus, labrum and linear lateral face marks clear ivory white; anterior tibiae mainly pale red; hind tibiae claviform, very broad apically; abdomen black. Brisbane (Hacker). Female unknown.

E. albolineata Ckll. Female a little over 5 mm. long, with dusky red abdomen; clypeus with a narrow pale yellowish stripe from base to apex, and sides of face with small short pale marks. Dorrigo, N.S.W. (W. Heron). Allied to *E. insularis*.

E. angophorae Ckll. Female, length about 6.25 mm.; black, with deep ferruginous abdomen and legs; clypeus with a longitudinal pale yellowish line or band; each side of face with a small pale yellow mark, which may be absent. Allied to *E. bicolor*, but known by the moderately dusky wings, much less reddened than in *E. bicolor*, and the abundant black hair on hind legs. Found by Froggatt at Sydney, visiting flowers of *Angophora*, but known to range north to Brisbane. The var. *obliterata* Ckll. from Brisbane, has the clypeal band dusky, narrow, very obscure; first abdominal tergite nearly all black, except the hind margin (broadest in middle) and broad hind corners. A table contrasting *E. angophorae* with its relatives will be found in Proc. Acad. Nat. Sci. Philadelphia, 1913, p. 32. The subsp. *occidentalis* Ckll. is from Yallingup, W. Australia, and has no light markings on face. The scape is red or yellowish red in front.

E. aterrima Ckll. First described as a variety of *E. botanica*, but later raised to specific rank. The female is fully 5 mm. long; abdomen all black, the hind margins of tergites not reddened. Considerably smaller than *E. insularis*, with the tubercles creamy white and the wings not reddened. The male differs by the clypeus (except a very small mark on each lateral margin) and labrum entirely white; the anterior tibiae and the basitarsi black or dark fuscous. Brisbane and Caloundra (Hacker).

E. baculifera Ckll. Female somewhat over 6 mm.; black, with the broad abdomen dark chestnut red, the first two tergites mainly black, and a dusky cloud on third; clypeus with a narrow rod-like pale yellow stripe, often subobsolete; tubercles dark. Allied to *E. angophorae* var. *obliterata*, but easily separated by the dark legs and abdomen. It is to *obliterata* what *robusta* is to *hamulata*. National Park, Queensland (Hacker).

E. bicolor Smith. This is the common species with red abdomen, with thin short orange hair on the apical part. The type female, in the British Museum, shows the face conspicuously narrowed below; this is an excellent character to distinguish it from the broad-faced *E. hamulata*. The male has the eyes large and prominent, and the face narrow. The range is extensive, from Stanthorpe, Queensland, to Tasmania, and west to Swan River. I took it at flowers of *Hypochaeris*, at Wallangarra, Queensland.

E. botanica Ckll. Female very small, less than 4.5 mm. long; black, including the abdomen, but the hind margins of the tergites reddish; face narrow, orbits converging below; clypeus with a very broad cream-coloured band, broadest above, with a sudden enlargement something like the head of a nail; tubercles cream-coloured. Botany, N.S.W. (Froggatt).

E. brisbanensis Ckll. Female about 5 mm. long; head and thorax shining black, abdomen rather dark chestnut red, the basal tergite and a broad transverse band on second blackened; face broad (but orbits distinctly converging below), shining, wholly without marking; flagellum red beneath. Allied to *E. froggattii* and *E. concinnula*, but easily separated by the black tibiae. Brisbane (Hacker).

E. clarissima Ckll. Male about 5 mm. long, the abdomen bright ferruginous, dusky at sides of apex, and the first tergite black, with a narrow red apical margin. Readily known by the small size and the broad white face-patch, broadly truncate above. Wings not reddened; knees broadly, and all the tibiae and tarsi, bright ferruginous. Yarrawin, N.S.W. (Froggatt).

E. concinnula Ckll. Female 4.5 mm. long, like *E. froggattii*, but smaller; the clear reddish wings with the stigma and nervures clear light ferruginous; femora black, red apically; tibiae and tarsi chestnut red; abdomen red without markings. The face is wholly black, but the labrum red. Collected by Froggatt in New South Wales.

E. diversipes Ckll. Male about 7 mm. long, known from *E. nitida* by the long black hair of face. The abdomen is black, and the anterior tibiae are dark (in *E. abstrusa* they are mainly pale red). Eyes very large, converging below; face with a very broad reversed T of greenish-white, including all of clypeus except a narrow stripe down each side; lateral marks represented by short slender lines; labrum greenish-white; tegulae black; hind tibiae slender basally and broad apically, their basitarsi long and very thick. National Park, Queensland (Hacker).

E. excavata Ckll. Female about 7.5 mm. long, peculiar for the wholly black, excavated and basin-like face; abdomen dark chestnut red, the first tergite with a broad blackish suffusion on disc; anterior knees, tibiae apically, and all the tarsi dark red; in certain lights the middle and hind tibiae appear to be bright red above, but this is due to coppery hair; tubercles black; wings strongly reddish. National Park, Queensland (Hacker).

E. froggattii Friese. Female 6 mm. long; head and thorax shining black; face narrow, wholly without light markings; tubercles black; femora black, red at apex, tibiae and tarsi bright chestnut red. The stigma is dusky (clear fulvous in *E. concinnula*). The type locality is Thornleigh, N.S.W. (Froggatt). It also occurs in Victoria.

E. fultoni Ckll. Female 5.5 mm. long; known by the small size, red femora, and absence of a cream-coloured clypeal stripe. Lower part of clypeus broadly suffused with red; mandibles red, except at base and apex; legs bright chestnut red; tubercles black; wings dilute reddish; stigma clear ferruginous; abdomen red, sometimes dusky at apex. Croydon, Victoria (S. W. Fulton).

E. gracilis Ckll. Female about 4.5 mm. long; slender, black, shining; face wholly black, labrum clear ferruginous; scape in front and flagellum beneath dull ferruginous; tubercles white; tegulae hyaline with a white spot. Distinguished from *E. ploratula* by the black middle and hind femora (in *ploratula* they are clear red). Brisbane (Hacker).

E. hackeri Ckll. First treated as a variety of *E. angophorae*; later as a species. The female resembles *E. angophorae*, but has the white clypeal band extremely broad, its upper half broadest, and covering the whole width of clypeus; lateral face marks quite large; triangular; first three abdominal segments with broad dusky bands, or these may be absent. The face marks resemble those of *E. clarissima*, but that has the scape white in front, while in *E. hackeri* it is entirely black. Brisbane (Hacker). The

var. *incerta* Ckll. has the lateral face marks reduced to small spots; stigma clear ferruginous; scape red at base.

E. hamulata Ckll. Female not quite 7 mm. long; abdomen chestnut red (a rather darker shade than in *E. bicolor*), the first two tergites each with a large black discal patch; legs red, the coxae, trochanters and greater part of femora black. The face is broad; clypeus with a cream-coloured band suddenly broadened above, with a sharp hook-like extension on each side; wings yellowish. Type from Moss Bay, N.S.W. (*Froggatt*), but goes north to Brisbane, and south to Tasmania. A Tasmanian variety has the clypeal mark evanescent, all but the upper part dark reddish; wings strongly reddened, stigma clear amber; hair on outer side of hind tibiae ferruginous.

E. insularis Ckll. Female about 6 mm. long; black, including abdomen; clypeal and lateral marks cream-colour; clypeus with a very broad median band, which suddenly broadens above, so as to include all of upper part; lateral marks rather small, subtriangular; scape with a red mark near base, and one at apex. Allied to *E. botanica*, but known by the lateral face marks and dark tubercles. Stradbroke Island, Queensland (*Froggatt*).

E. melaena Ckll. Female about 5 mm. long; similar to *E. aterrima*, but differing by the face entirely black; wings dilute reddish; a bright ferruginous patch at each side of base of first abdominal tergite; tibiae largely red, but basitarsi dark. Caloundra, Queensland (*Hacker*).

E. nitida Ckll. Both sexes about 6 mm. long. Female black, with the margins of the fourth and fifth abdominal tergites very narrowly and often hardly perceptibly reddened; face and front highly polished and shining; clypeus with a very broad cream-white band, broadest above; tubercles cream-colour; tegulae black; wings dilute brown, stigma and nervures very dark. Male similar to that of *E. aterrima*, but larger, head broader, creamy-white area on face broader, wings browner. The larger size, brownish wings and black legs distinguish this species from the closely related *E. aterrima*. Stradbroke Island, Queensland (*Hacker*).

E. perpensa Ckll. Male about 6 mm. long; head and thorax black, with long hair, black on head, dull white on thorax, very faintly yellowish dorsally; head transverse, eyes very large and convex; clypeus and labrum greenish-white, the light facial area like a reversed wineglass with an extremely thick stem; no lateral marks; tegulae dark; stigma narrow, ferruginous; abdomen parallel-sided, broad at base (slender basally in *E. bicolor*), first tergite black, second black, with dull red apical margin, fourth red clouded with dusky, fifth and sixth more strongly clouded. Structurally allied to *E. diversipes*, but that has a black abdomen. Armidale, N.S.W. (*A. J. Turner*).

E. pictifrons Alfken. Male 6 to 7 mm. long; black, with red abdomen; clypeus and scape in front yellowish-white. The variety *laeta* Alfken has only the base of the first tergite black, but the typical form has the abdomen more blackened, and in the var. *obscura* Alfken, the tergites are black, with basal and apical red bands. Mundijong, S.W. Australia. *E. angophorae occidentalis* Ckll., based on females from Yallingup, W. Australia (*R. E. Turner*) is very likely the same species. It has the face narrowed below, all black; scape red or yellowish red in front; wings reddish, with dark stigma; legs largely red. Alfken's name has about seven years' priority. If these are one species, this leaves W. Australia with only two known *Exoneura*. It is possible that Smith's *E. bicolor* from Swan River and Tasmania were different species, the Tasmanian one being the one to which the name is now applied. Meade-Waldo compared *occidentalis* with the type of *E. bicolor*, and reported: "Not *E. bicolor*; differs in colour of hind legs, etc."

E. ploratula Ckll. Female hardly 4.5 mm. long; head, thorax and abdomen entirely black, the face without light markings; legs chestnut red, the anterior femora black, except at apex, but the others clear red; scape red in front; wings yellowish hyaline, not dusky, nervures light ferruginous, the large stigma dark red. Resembles *E. froggattii* by the small size and dark face, *E. botanica* by the small size and black abdomen. Sydney, N.S.W., collected by Froggatt at flowers of *Angophora*.

E. rhodoptera Ckll. Female about 6 mm. long; very robust, black, the abdomen marked with dark red, at sides of first and second tergites, a pair of hook-shaped marks on second tergite, a transverse band (weak or broken sublaterally) on third, base of fourth, and an indistinct band on fifth; clypeus with a broad median cream-coloured bar, irregular along the margins, and emitting at its upper end very long hook-like extensions; labrum black; tegulae reddish; wings strongly reddish-fuliginous; femora with a pale red stripe above, not reaching base; anterior and middle tibiae and tarsi dark red, hind legs darker. Allied to *E. hamulata*, but with very much darker abdomen, legs and wings. Stradbroke Island, Queensland (Hacker).

E. robusta Ckll. Both sexes about 6.5 mm. long. Female robust, black, the very broad abdomen shining dark chestnut red, with the first tergite (except apical margins laterally), nearly all of second, and a transverse arched band on third, black; face very broad, the clypeus with a broad cream-coloured band, variable in form, urn-shaped or hooked at sides above; antennae dark; tubercles black, tegulae black, reddish posteriorly. Male with narrow face, showing long black hair, and no light markings; abdomen darker, even the apical tergites suffused with black. There is a possibility that the male is not conspecific. The female is close to *E. hamulata*, with the same broad face, but easily distinguished by the much darker legs, only partially and very obscurely reddened, if at all. National Park, Queensland (Hacker).

E. tasmanica Ckll. Male about or nearly 7 mm. long; abdomen red, suffused with black, first tergite black with red hind margin; clypeus cream-colour; antennae black; knees, tibiae and tarsi clear red, the hind tibiae black posteriorly. Windermere, Tasmania (F. M. Littler).

E. tau Ckll. Similar to *E. hamulata*, but smaller (anterior wing 4 mm.); second cubital cell much smaller; clypeal stripe narrow, with a short cross-bar at top, which is not at all hooked; tubercles yellow. By the light tubercles it resembles *E. botanica*, but that has a black abdomen, dark stigma and clypeal stripe very much broader. Moss Bay, N.S.W. (Froggatt).

E. turneri Ckll. Female about 8 mm. long; head and thorax black, wholly without light markings; abdomen bright chestnut red, the first tergite with two rather small dusky spots near base; femora, tibiae and tarsi bright chestnut red, anterior femora black at extreme base; face broad; scape with a narrow red stripe in front; wings strongly reddened. Allied to *E. hamulata*, but separated by the entirely black face. Eaglehawk Neck, Tasmania (R. E. Turner).

It will be observed, that of the above 28 species of *Exoneura*, twelve were discovered by Hacker, and nine by Froggatt. We are not informed who discovered the genus; Smith cites the type species, *E. bicolor*, from Swan River and Tasmania.

Family CTENOPLECTRIDAE.

Ctenoplectra australica Ckll., from Claude River, Queensland, is the only species. Its characters have been given in connection with the table of families.

(To be Continued.)